FSS Survey Series No. 2006/01

Deepwater Survey Report 2006

by

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Keywords: Deepwater fisheries, Porcupine Bank, Shelf edge, Fisheries, CTD, Hydrography, Invertebrates.

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Abstract

The Marine Institute fisheries science services carried out a deepwater survey in 2006, to revisit earlier survey areas from the nineties and investigate the impact of the high levels of exploitation on the abundance and biological parameters of the deepwater species. The survey was carried out in three areas, two of which were located on the western continental slope and the third on the northern slope of the Porcupine Bank. Hauls were made at four depths, 500m, 750m, 1000m and 1500 meters. Eight comparative tows were made with the Scottish research vessel, RV *Scotia*. The object of the survey was to collect biological information on the main deepwater fish species, and also to collect benthic invertebrates and bottom sediment samples. CTD transects, grab sampling, and cetacean studies were also carried out. 126 species of fish were identified along with 131 species of invertebrates. The survey will be the basis for further collaborative work with FRS in future years, and provide a timeseries for CPUE for the main deepwater species.

1 Introduction

The Marine Institute fisheries science services ran a series of deepwater surveys along the northeastern shelf edge between 1992 and 1999. This survey programme was an important source of information on the distribution and abundance of deepwater fishes during the early development of the commercial fishery. Since then the fishery has drastically expanded and the deepwater commercial species as well as species taken as a bycatch have experienced severe fishing pressure, with many of the stocks being depleted or close to depletion. It was the aim of the 2006 deepwater survey to revisit the initial survey areas of the nineties and investigate the impact of the high levels of exploitation on the abundance and biological parameters of the deepwater species.

The specific objectives of the 2006 FSS deepwater survey were:

- To investigate the distribution and relative abundance of shelf edge, slope and deepwater fishes at three different sites in the north-east Atlantic.
- To collect biological information on the main deepwater species including length, weight, maturity, sex ratio and feeding.
- To coordinate the survey with the annual Scottish deepwater survey that is carried out in ICES Sub division VIa and compare the data collected during comparative tows.
- To collect hydrographic data along three transects across the continental slope.
- To collect benthic invertebrates and bottom sediment samples for the description of the benthic deepwater habitat.
- To collect ancillary data for ecosystem description including cetacean abundance and fishing activity.

2 Materials and Methods

2.1 Scientific Personnel

Name	Service area/Affiliation	Role
Nils-Roar Hareide	Runde Environmental Centre	Scientist in charge
Brendan O'Hea	MI - FSS	Scientist
Graham Johnston	MI - FSS	Scientist
Hans Gerritsen	MI - FSS	Scientist
Finlay Burns	FRS Aberdeen	Scientist
Mairead Sullivan	MI - FSS	Scientist
Yvonne Leahy	MI - FSS	Scientist
Edward McCormick	MI - FSS	Scientist
Sean O' Connor	MI - FSS	Scientist
Clive Trueman	SOC Southampton	Scientist
Dave Wall	IWDG	Cetacean expert
Stephen Comerford	GMIT	Scientist

2.2 Survey Plan

2.2.1 Area of operation

The survey was carried out in three areas, reflecting fishing areas covered during the Irish deepwater survey programme in the 1990s. Two areas were located on the western continental slope (FRS regions 2&4) and one area on the northern slope of the Porcupine Bank (FRS region 5). The overall sampling area, with fishing tows, is shown in figures 1-3. The 2006 deepwater survey was coordinated with the Scottish deepwater survey that covers the slope in area VIa from 55º to 58.5ºN

2.2.2 Specific operations

Fish tows

In each area trawl hauls were made at four depths, 500m, 750m, 1000m and 1500 meters, Table 1. At least two hauls were carried out at each depth in each area. The hauls were carried out along the slope. Information on possible clean fishing tows were derived from seabed mapping information, clean tows registered during the Irish deepwater survey program in the 1990s, tows from the FRS survey in areas 2 and 4, and in-

formation from SODENA, as available. Each night these potential sites were surveyed in detail, and clean tows selected.

Effective fishing time was taken from when the trawl doors settled on the bottom, to the net being hauled. The effective fishing time was set at two hours.

Comparative Tows

As part of its 2006 survey programme FRS fished in Areas 1, 2 & 3 plus the northern half of area 4. It was decided that a number of comparison tows would take place, three in area 2 and three in area 4, at depths of 500m, 1000m, and 1500m. The *RV Scotia* provided shooting and hauling positions from known tows for the 3 depths at 500m, 1000m and 1500m in area 2, and for 1000m and 1500m in area 4, Table 2. The *Celtic Explorer* would find a suitable tow at 500m in area 4 and pass it back to FRS. This would give 6 comparative tows for the first year.

CTD transects

One CTD transect was carried out in each area. The stations were at 500m, 750m, 1000m, and 1500m.

Sediment grabs

Sediment grabs were taken at each CTD station. These were then be sieved on a 63µ mesh and fixed in 4% formalin.

Invertebrate sampling-

All Invertebrates from the trawls were identified as far as possible, their catches weighed and entered into the database, as during the ground fish survey. Invertebrates chosen for the reference collection were preserved in 4% buffered formaldehyde. Samples which could not be identified would be brought back to the laboratory for further work.

Cetacean studies

A single marine mammal observer was present on board during the survey and conducted watches from the ‘crow’s nest’ located above the bridge, 18m above sea level. Observer effort focused on a 90 degree arc ahead of the ship; however sightings located up to 90 degrees to port and starboard were also included. The observer scanned the area by eye and using 7 X 50 binoculars. Bearings to sightings were measured using an angle board and distances were estimated with the aid of distance measuring stick. Environmental data were recorded every 15 minutes using Logger

2000 software (IFAW 2000). Sightings were also recorded using Logger 2000. Automated position data were obtained through a laptop computer linked to a GPS Receiver Unit.

During the cetacean survey, a lookout was kept for any fishing vessels or fishing gear operating in the area. Vessel locations and fishing activity were noted where possible.

Acoustic sampling

The Simrad ER-60 split-beam transducer was run throughout the survey, recording from the surface to 1500m depth. This was used to look at changes in depth of the meso-pelagic layer, normally at 200m – 600m, and also to look for any concentrations of fish that could be associated with particular depths, areas or tows. The acoustic files were saved to DVD on a daily basis, and are available to anybody wishing to examine these features in greater detail in the future.

2.3 Equipment and system details and specifications

BT184 deepwater trawl

CTD

Hammon Grab

Shipek Grab

Simrad ER-60

Electronic Data Capture system

2.4 Protocols used

At each station the entire catch were speciated and weighed. For each species a random sample of the entire catch was taken for length measurements. Conversion factors (total length to pre-anal fin length) were established for Roundnose, Hollow-nose and Murray's grenadiers.

Length measurements for various fish species were agreed on;

Sharks	total length
Skates	total length
Chimaeras	snout to base of third dorsal fin

Grenadiers	snout to base of anal fin
Bony fish	total length
Orange Roughy	standard length
Black Scabbard	total length.
Smoothhead	total length

3 Results

Fish tows

A total of 27 tows were carried out, ten in area 5, ten in area 4, and seven in area 2, Table 1. Of these five were invalid, due either to the net tearing, or coming fast, Table 3. The net tore on two occasions, but repairs were carried out as the ship steamed between areas, so no time was lost.

Fish sampling

A total of 126 fish species were identified from an estimated catch of 70,038 individuals, (25 tonnes). Of those 27,574 were measured. The twenty most abundant species (by numbers) are given in Table 5. Biological sampling (individual weight, sex, maturity and age) was carried out on a total of 1587 individuals of the target species shown in Table 6. Due to the lack of information available on many deepwater species additional biological sampling (weight, sex, maturity, but no age) was carried out, on an ad-hoc basis, on a further 1350 individuals, Table 7. Similar to the invertebrates geographical and depth distributions were also apparent in fish, Figure 4, Table 8. Photographs were taken of many species, especially the rarer ones, for identification purposes. Samples of certain species were also frozen, for later work in the laboratory. These samples and photographs can be used for training purposes before future surveys.

Invertebrate sampling-

A total of 131 species types were identified in the 27 trawls, specimens of which were kept for formal identification later. Photographs of all of the species recorded were taken and it is hoped to produce a pictorial key for future surveys. Many of the samples collected were not in the taxonomic keys available for the survey and it is hoped that most of the specimens collected will be identified to species with the more extensive literature available in the Institute.

In terms of numbers of species and abundance the Echinodermata appeared to dominate the fauna. There were two exceptions to this. Firstly haul 17 (area 2, 1000m) where the trawl consisted largely of eight species of prawns (2.6kg). Secondly, haul 21 (area 2, 500m) where a small clam *Pseudamussium septemradiatum* dominated the fauna (0.75kg)

The anthozoan *Epizoanthus incrustatus* with the hermit crab *Parapagurus pilosimanus* were very abundant in the deep water trawls both the 1500m and the 1000m in area 5. However it only occurred in significant numbers in one other trawl and that was in area 4 at 1000m. Similarly the holothurian, *Neopentadactyla* sp., was present in large numbers in area 5 in the deeper stations (1500m and 1000m), but absent from other areas and depths. Prawn sp#2 and sp#3 were abundant in all areas at depths of 1000m and 1500m. The urchin, Echinoid sp#3, was abundant at 750m to 1000m in areas 2 and 4, but was absent in from the deeper and shallower trawls and area 5 entirely. Holothu-

rian sp#5 was only present in from the shallower depths in areas 2 and 4 but was absent entirely from area 5.

From these preliminary results there appears to be a depth and a geographical aspect to the distribution of the species collected, Figure 4, Table 10.

In all areas the deeper waters had a greater variety of species, of which 1 or 2 species appeared to dominate.

For the benthic perspective the most interesting samples taken was the clay-stone caught in the net at 1500m in area 4. It was covered in burrows that were formed by 3 different species of Ophiuroid, and opportunistically occupied by Sabellid and Serpulid polychaetes, and a further as yet unidentified species. Also present in the burrows were blue and green sponges, as well as an anemone. Various crustacea and bivalves were also present. The biological activity was largely confined to the upper 2.5 to 4cm from the surface.

Thirteen specimens of Sea pens (3 species) were collected as requested for Paul Tyler (Southampton Oceanographic Centre). Fifteen species of Crustacea from a variety of areas and depths were collected for Dave McGrath (GMIT). *Nephrops norvegicus* samples were collected for Dr. Colm Lordan, Marine Institute, Ireland. They were found in areas 2 & 4 at depths of 500m and 750m.

Grab Samples

A total of 22 grab samples were collected, seven in area 5, five in area 4, and ten in area 2, Table 9. It had been intended to use a Hammon grab for collecting benthic samples, however, after a few unsuccessful hauls, it was decided to use the smaller Shipek grab instead, making two hauls per site. Samples were sieved on a 63µ mesh, and fixed in 4% formalin. Polychaetes were the main invertebrates collected using the grabs, although some echinoids, ophiuroids, and small squat lobsters were recovered. It was noted that heavier equipment, such as a box core, should be used in waters at this depth.

CTD transects

All the casts were successful. Temperatures ranged from 15.0ºC at the surface, to 4.3ºC at 1500m. Salinity ranged from 35.49 to 34.94, Figure 5.Positions of the casts are shown in Table 4.

Fecundity sampling for Black Scabbard:

40 ovaries were collected from black scabbard, *Aphanopus carbo*. These were distributed over different depths and the three different areas. The small sample collected reflected the fact that the majority of black scabbard sampled were at the same developmental stage.

Genetic Sampling for Deepwater sharks:

Finclip samples were collected for Virginia Institute of Marine Science. The number of samples collected was lower than that requested due to the absence of the fish.

Centroscymnus coelolepsis -	28/50 individuals requested
Centrophorus squamosus -	45/50 individuals
Centrophorus granulosus -	0/5
Centrophorus lusitanicus -	0/5
Deania calcea -	5/5
Deania profundorum -	0/5
Deania hystricosa -	0/5

Genetic Sampling

Flesh samples were collected from 125 Black scabbard (*Aphanopus carbo)*, and 100 Roundnose grenadier (*Coryphaenoides rupestris)* for IMR in Bergen. The samples were spread across all three areas. Also finclips from 20 four-spotted megrim *(Lepidorhombus boscii)* were collected for a Portuguese student.

Stomach content

All fish, where age data was collected, were examined for stomach content. Instances of empty stomachs were recorded. It had been intended to collect 100 stomachs, to check their contents. However the majority of fish landed came up empty. Where stomachs had some content they were examined on the spot.

Cetacean Survey Results

68 hours of survey time were logged with 40.2% (27.3hrs) of this at ≤ Beaufort sea state three. Eighteen sightings of at least four cetacean species, totalling 665 individuals were recorded.

Identified cetacean species were common dolphin (*Delphinus delphis*), pilot whale (*Globicephala melas*) and fin whale (*Balaenoptera physalus*). A number of sightings of unidentified beaked whale species were also made. One of the beaked whale sightings was thought to be of two breaching northern bottlenose whales (*Hyperoodon ampullatus*), while another was thought to be one of the *Mesoplodon* species; Sowerby's beaked whale (*Mesoplodon bidens*), Gervais' beaked whale (*Mesoplodon europaeus*) or True's beaked whale (*Mesplodon mirus*).

Pilot whales were the most commonly encountered species along the continental shelf slopes, while common dolphins were only encountered over shallower waters on the continental shelf. The distribution of beaked whale sightings appears to correlate well with the presence of deep water canyons along the shelf slopes

Species lists were made of all bird species seen around the survey vessel each day. As many of the bird species present in the area follow fishing vessels, it was decided to do a count of the maximum group size for each bird species around the vessel; this gives a minimum daily count for each species seen. Maximum group size counts were focused on period when the nets were being hauled and birds congregated to feed on discards.

15 bird species were recorded during the survey. Eight of these were seen on a regular basis: lesser black backed gull (*Larus fuscus*), great skua (*Stercorarius skua*), gannet (*Morus bassanus*), fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*), sooty shearwater (*Puffinus griseus*), kittiwake (*Rissa tridactyla*) and storm petrel (*Hydrobates pelagicus*). Fulmars and great shearwaters were the most common species seen.

Two tern species were also noted; common tern (*Sterna hirundo*) and Arctic tern (*Sterna paradisaea*). Pomerine skuas (*Stercorarius pomarinus*) were noted on two occasions, Manx shearwaters (*Puffinus puffinus*) were sighted on day one and a juvenile Mediterranean gull (*Larus melanocephalus*) was noted on one occasion.

Foggy conditions brought a number of waders and passerines to the ship including pipits, warblers and a finch. A merlin (*Falco columbarius*) also spent some days on board the vessel, feeding on passerines. It should be noted that the primary focus of the survey was on cetaceans; therefore some bird species may have gone unrecorded during the current survey.

Little fishing activity was noted in the survey area overall. Just 4 vessels were noted in the survey area. All fishing activity was recorded in or around Area 5. Two Dahn buoys were also noted in area 5, which were thought to be marking bottom set gill nets or long lines.

Sampling for stable isotope analyses

Muscle tissue and otolith samples were taken for stable isotope analyses. The aim of sampling was to provide a small number of a wide range of species for otolith sampling in order to compare life history variables, and a larger number of individuals for tissue analyses. Non-commercial species were targeted as well as commercial species to provide a more representative picture of ecosystem structure.

299 otoliths were recovered from 24 species including all highest priority target species (*A. carbo, H. atlanticus, C. rupestris*). These otoliths will be used to characterise age-depth histories for collected species, to assess the total proportion of a fish's growth cycle spent at a particular depth, and, in faster growing otoliths, to confirm summer-winter growth periods and thus validate age assessments.

A total of 882 tissue samples from 37 species were collected and the most abundant species were sampled in at least two areas per trawl depth, Table 11. Care was taken to sample the full range of body sizes for the most abundant species. This will allow robust assessment of dietary separation between and within species and will be used to identify generalist and specialist feeding strategies and to study the role of individual species in delivery of carbon to deeper waters.

In all the sampling program was extremely successful and it is anticipated that several research programs (including PhD's) will be initiated on the basis of the samples collected.

Outstanding work to be completed.

The data is currently being analysed and will be compared to data collected on the Scottish survey. Comparisons will also be made with the historical data from the Irish surveys of the 1990s. At present all the otoliths are being held in storage for future ageing.

4 Discussion and Conclusions

The survey was extremely successful. A total of 27 hauls were carried out, with at least one in each strata. 126 species of fish and 131 species of invertebrates were identified. The survey provided a platform for scientists to carry out a number of multidisciplinary programmes. Additional sampling carried out by scientists from the Southampton Oceanographic Centre will provide data for several research programmes. Samples were also collected for a number of scientists in Europe and the United States.

The survey will be the basis for further collaborative work with FRS in Aberdeen. It will also be the start of a time series to be used for future stock assessments by various ICES working groups. The survey can also be used by external scientists to collect data for their own research purposes.

Table 1. Table of trawl positions

Haul	Date	Shot Lat	Shot Lon	Haul Lat	Haul Lon	Depth	Area
1	05/09/2006	54º 03.48	-12º 47.65	54º 03.49	-12º 56.27	1131	5
2	06/09/2006	54º 05.15	-13º 00.19	54º 04.92	-12º 45.35	1281	5
3	06/09/2006	54º 07.95	-12º 48.96	54º 07.36	-13º 02.70	1496	5
4	06/09/2006	54º 02.29	-03º 03.49	54º 01.87	-12º 50.44	998	5
5	07/09/2006	53º 56.38	-13º 57.77	53º 58.80	-13º 45.10	1503	5
6	07/09/2006	53º 53.80	-13º 42.85	53º 50.74	-13º 54.14	999	5
7	07/09/2006	53º 50.31	-13º 44.50	53º 48.37	-13º 48.57	757	5
8	07/09/2006	53º 53.59	-13º 17.12	53º 52.00	-13º 28.56	432	5
9	08/09/2006	53º 58.74	-12º 43.23	53º 59.32	-12º 56.37	747	5
10	08/09/2006	53º 56.65	-12º 55.55	53º 56.80	-12º 52.42	455	5
11	09/09/2006	55º 24.51	-10º 01.89	55º 17.18	-10º 07.38	1004	4
12	09/09/2006	55º 14.05	-10º 09.13	55º 08.66	-10º 10.19	1058	4
13	09/09/2006	55º 06.04	-10º 16.48	55º 09.76	-10º 15.95	1550	4
14	10/09/2006	55º 15.88	-10º 04.03	55º 23.09	-09º 59.35	739	4
15	10/09/2006	55º 23.31	-09º 56.82	55º 16.40	-10º 01.18	520	4
16	11/09/2006	56º 39.82	-09º 12.11	56º 47.29	-09º 11.50	1053	2
17	11/09/2006	56º 44.53	-09º 10.13	56º 36.15	-09º 14.55	979	2
18	11/09/2006	56º 44.03	-09º 21.01	56º 52.82	-09º 20.60	1459	2
19	12/09/2006	56º 48.48	-09º 05.19	56º 50.43	-09º 08.11	771	2
20	12/09/2006	56º 53.91	-09º 19.59	56º 45.60	-09º 21.24	1475	2
21	12/09/2006	56º 38.28	-09º 03.60	56º 45.19	-09º 02.22	476	2

22	12/09/2006	56º 44.14	-09º 01.96	56º 39.87	-09º 01.78	503	2
23	13/09/2006	55º 22.01	-09º 58.15	55º 16.25	-10º 01.15	526	4
24	13/09/2006	55º 13.02	-10º 17.74	55º 09.99	-10º 16.86	1490	4
25	14/09/2006	55º 16.31	-10º 03.91	55º 22.97	-09º 59.30	735	4
26	14/09/2006	55º 15.18	-10º 01.93	55º 08.23	-10º 04.74	493	4
27	14/09/2006	54º 59.39	-10º 22.37	54º 56.01	-10º 33.16	1488	4

Table 2. Table of comparative trawl positions

Haul	Date	Shot Lat	Shot Lon	Haul Lat	Haul Lon	Depth	Area
1	18/09/2006	56° 48.22	-09° 04.18	56° 41.08	-09° 01.94	550	2
2	18/09/2006	56° 50.19	-09°10.72	56° 43.71	-09° 10.78	1030	2
3	19/09/2006	55° 14.12	-10° 02.36	55° 06.92	-10° 04.80	500	4
4	19/09/2006	55° 12.04	-10° 10.21	55° 08.99	-10° 10.69	1050	4
5	19/09/2006	54° 58.33	-10° 27.34	54° 56.54	-10° 32.15	1500	4
6	21/01/1900	55° 17.57	-10° 03.68	55° 23.45	-09° 59.84	750	4
7	23/09/2006	56° 51.92	-09° 20.31	56° 45.48	-09° 22.35	1500	2

Table 3. List of valid tows

	500 m		750 m		1000 m		1500m		Total
	Valid	Invalid	Valid	Invalid	Valid	Invalid	Valid	Invalid	
Area 5	1	1	2		3	1	2		10
Area 4	2	1	2	1	2		1	1	10
Area 2	2		1		2		2		7
Total	5	2	5	1	7	1	5	1	27

Table 4. CTD positions and depths

CTD No.	Date	Time	Longitude	Latitude	Depth
1	05/09/2006	23.35	54° 07.84	-12° 58.39	1498
2	06/09/2006	1.33	54° 02.31	-12° 56.55	998
3	06/09/2006	2.50	53° 59.52	-12° 55.62	736
4	06/09/2006	3.50	53° 56.83	-12° 54.70	461
5	09/09/2006	20.27	55° 20.53	-10° 12.26	1503
6	09/09/2006	22.15	55° 17.95	-10° 06.48	989
7	10/09/2006	0.32	55° 16.85	-10° 03.58	747
8	10/09/2006	2.25	55° 16.07	-10° 01.50	503
9	11/09/2006	20.36	56° 53.57	-9° 22.43	1527
10	11/09/2006	23.00	56° 44.29	-9° 09.76	1001
11	12/09/2006	0.30	56° 41.43	-9° 05.25	751
12	12/09/2006	1.25	56° 41.17	-9° 01.43	491

Table 5. The 20 most abundant species (by number)

Species		Catch nos
Coryphaenoides rupestris	Roundnose grenadier	17568
Helicolenus dactylopterus	Blue-mouth redfish	7142
Nezumia aequalis	Smooth rattail	6718
Argentina silus	Gt silver smelt	5582
Lepidion eques		4319
Coelorhynchus coelorhynchus	Hollow nosed rattail	3201
Trachyrhynchus murrayi	Murray's rattail	3072
Chimaera monstrosa	Rabbit fish(rat-tail)	2789
Alepocephalus bairdii	Baird's smooth head	2543
Micromesistius poutassou	Blue whiting	2329
Xenodermichthyes copei		2223
Coelorhynchus labiatus	Spearsnouted grenadier	1034
Rouleina sp.		1000
Halargyreus affinis (H.johnsonii)		950
Galeus melastomus	Blackmouthed dogfish	883
Aphanopus carbo	Black scabbard fish	828
Trachurus trachurus	Horse-mackerel (scad)	815
Phycis blennoides	Greater forkbeard	720
Coryphaenoides guntheri	Günther's grenadier	650
Synaphobranchus kaupi	Cut-throat eel	594
Deania calceus	Birdbeak dogfish	528
Hoplostethus atlanticus	Orange roughy	434

Hydrolagus mirabilis	Ratfish	315
Epigonus telescopus	Cardinal fish	290
Glyptocephalus cynoglossus	Witch	255

Table 6. List of species on which biological sampling was carried out.

Species		Code	Target	Collected
Hoplostethus atlanticus	Orange roughy	RHF	450	434
Coryphaenoides rupestris	Roundnose grenadier	RNG	375	563
Aphanopus carbo	Black scabbard	BSF	900	353
Molva molva	Ling	LIN	300	30
Molva dypterygia	Blue ling	BLI	300	79
Brosme brosme	Tusk	USK	225	19
Lophius piscatorius	Monkfish	MON	all	36
Centrophorus squamosus	Leafscale gulper shark	CSQ	all	45
Centroscymnus coelolepis	Portuguese dogfish	PUS	all	28
Total				1587

Table 7. List of species on which additional biological sampling was carried out.

Species		Code	Collected
Chimaera monstrosa	Rabbit fish(rat-tail)	RBF	240
Phycis blennoides	Greater forkbeard	GFB	116
Merluccius merluccius	European hake	HKE	102
Hydrolagus mirabilis	Ratfish	RTF	91
Etmopterus princeps	Greater lantern shark	ESP	85
Centroscymnus crepidater	Longnose velvet dogfish	CMS	80
Coelorhynchus labiatus	Spearsnouted grenadier	SSG	70
Deania calceus	Birdbeak dogfish	DCA	66
Harriotta raleighana	Narrownose chimera	NNC	64
Helicolenus dactylopterus	Blue-mouth redfish	RBM	57
Alepocephalus bairdii	Baird's smooth head	BSD	55
Nezumia aequalis	Smooth rattail	SRL	50
Coryphaenoides guntheri	Günther's grenadier	CGU	42
Argentina silus	Gt silver smelt	GSS	41
Coelorhynchus coelorhynchus	Hollow nosed rattail	HRT	40
Hydrolagus affinis	Smalleyed rabbitfish	HAF	33
Lepidion eques		LPE	30
Chalinura mediterranea	Mediterranean grenadier	CME	23
Epigonus telescopus	Cardinal fish	EGT	23
Etmopterus spinax	Velvet belly	VBY	13
Centroscyllium fabricii	Black dogfish	CSF	8
Hexanchus griseus	Six-gilled shark	SGS	4

Raja batis	Common skate	SKT	4
Mora moro	Mora	MOM	4
Rhinochimaera atlantica	Straightnose rabbitfish	RHA	3
Galeus murinus	Mouse catshark	DGM	1
Squalus acanthias	Spurdog	DGS	1
Hydrolagus pallidus		HPS	1
Raja fyllae	Round skate	RDS	1
Raja naevus	Cuckoo ray	CUR	1
Galeus melastomus	Blackmouthed dogfish	DBM	1
Total			1350

Table 8. Catch number by depth and area for the major species

Station	Area	Depth (m)	*Coryphaenoides rupestris*	*Chimaera monstrosa*	*Argentina silus*	*Alepocephalus bairdii*	*Helicolenus dactylopterus*	*Deania calceus*	*Aphanopus carbo*	*Galeus melastomus*	*Rouelina* sp.	*Phycis blennoides*
1	5	1000	31			274		19	52			
2	5	1000	555			36		3	82			
3	5	1500	1218			114			5		29	
4	5	1000	84	1		85		115	81			2

5	5	1500	772	4		85			2		26	
6	5	1000	151			16		146	26		1	2
7	5	750	2	34			15	86	5			9
8	5	500		584	141		858	6		23		14
9	5	750		257	2		125	537	2			36
10	5	500		1	2		5	2				
11	4	1000	252	2	1	18		74	2			4
12	4	1000	377	19		412		32	8			
13	4	1500	33			41		7			5	
14	4	750		152	494		17	139	2	14		27
15	4	500		43	53		1	5	3	1		
16	2	1000	97	6		34		9	54			1
17	2	1000	149	23		11		24	45			4
18	2	1500	964	27		218			4			
19	2	750	7	13	5	2	18	33	153	1		81
20	2	1500	5	14		263			11			
21	2	500		351	18		58		6	227		17
22	2	500		196	7		33	2	2	17		41
23	4	500		436	198		58			4		58
25	4	750		61	679		4	51	14	9		23
26	4	500		546	756		125	3		61		45
27	4	1500	873	3		29			7		174	
Total			5570	2773	2356	1638	1317	1293	566	357	235	364

Table 9. Sites and composition of grab samples

	Latitude	Longitude	Depth	Equipment	Comments
Grab 1	54 01.802'N	12 48.461'W	997	Hammon	Very little sediment; sieved to 0.63um; changed to Shipek
Grab 2	54 01.799'N	12 48.464'W	997	Shipek	Very poor returns; sieved to 0.63um
Grab 3	53 56.296'N	13 24.896'W	771	Shipek	1 large pebble; fine sand, clean, mainly composed of foraminif-era. 1 brittle star with black cone shaped disc - gravid. 1 polychaete tube. Sieved to 0.63um
Grab 4	53 54.621'N	13 22.556'W	489	Hammon	Fine sand, large rock, some pebbles. Some worms, squat lobsters and ophiuroids. Sieved to 0.63um
Grab 5	53 58.553'N	12 38.920'W	818	Shipek	Fine sand with small stoney bits; Amphi-nomid, Amphipod, tube worms
Grab 6	53 58.590'N	12 38.894'W	834	Shipek	Coarse sand as above; photo taken; polychaete tubes
Grab 7	53 58.588'N	12 38.891'W	832	Shipek	Coarse sand over layer of very thick white clay, "potters clay", sticky
Grab 8	55 17.940'N	10 06.488'W	1004	Shipek	Echinoid with sand and pebbles
Grab 9	55 16.854'N	10 03.578'W	763	Shipek	Fine sand + a large rock; small ophiuroid; one worm, possibly Amphinomid

					Fine sand; worm-like creature - Siphuncu-lan?, clear deep-red colon,
Grab 10	55 16.859'N	10 03.577'W	762	Shipek	intestine could be seen through body wall, short tentacles at anterior end
Grab 11	55 16.076'N	10 01.490'W	514	Shipek	Thick muddy sediment; deep purple worm-like creature - Echiuran?
Grab 12	55 16.070'N	10 01.485'W	515	Shipek	Thick muddy sediment; no obvious fauna
Grab 13	56 43.418'N	09 25.027'W	1527	Shipek	Thick mud; no obvious fauna
Grab 14	56 43.403'N	09 25.024'W	1525	Shipek	Some polychaete tubes
Grab 15	56 41.941'N	09 10.563'W	1016	Shipek	Thick heavy mud; no visible fauna
Grab 16	56 41.940'N	09 10.571'W	1018	Shipek	Thick mud; numerous polychaetes visible; spicules in mud
Grab 17	56 41.402'N	09 05.211'W	763	Shipek	Thick mud, some coarser material; sev-eral polychaetes visible
Grab18	56 41.394'N	09 05.206'W	765	Shipek	Thick mud; tube worms visible
Grab 19	56 41.170'N	09 01.420'W	503	Shipek	Sandy sediment; Laonice terbellidae type tube
Grab 20	56 41.171'N	09 01.408'W	501	Shipek	Sandy sediment with 1 pebble; Maldanidae tube; ophiuroid
Grab 21	56 41.076'N	08 58.328'W	177	Shipek	Coarse sand and peb-bles; bryazoa on peb-bles
Grab 22	56 41.013'N	08 58.290'W	171	Shipek	No visible fauna

Table 10. Invertebrate fauna from trawls

Area 5		Area 4		Area 2	
1500m		**1500m**		**1500m**	
Haul 2		Haul 20		Haul 18	
Anthozoa sp#1	v. abundant	Stichasteridae sp#1	abundant	Echinoid sp#1	few
Epizoanthus incrustatus + hermit crab	v. abundant	Palaemon sp#1	abundant	Echinoid sp#2	few
Neopentadactyla sp.	v. abundant			Prawn sp#2	few
Cushion Star sp#1	abundant	Haul 27		Prawn sp#3	few
		Echinoid sp#4	numerous	Palaemon sp#1	numerous
Haul 3		Holothurian sp#4	numerous		
Echinoid sp#2	v. abundant				
Epizoanthus incrustatus + hermit crab	abundant				
Haul 5					
Epizoanthus incrustatus + hermit crab	v. abundant				
Stichopus sp#1	v. abundant				
Palaemon sp#1	abundant				
Prawn bits	abundant				
1000m		**1000m**		**1000m**	
Haul 1		Haul 11		Haul 16	
Earred octopus sp#1	v. abundant	Prawn sp#2	v abundant	Prawn sp#2	v. abundant
Echinoid sp#1	v. abundant	Echinoid sp#3	abundant	Prawn sp#3	v. abundant
Stichopus sp#1	v. abundant	Pasiphaea multidentata	abundant	Echinoid sp#4	abundant
Anthozoa sp#1	abundant	Prawn sp#3	abundant		
Neopentadactyla sp.	abundant			Haul 17	
		Haul 12		Echinoid sp#3	v.v.abundant
Haul 4		Epizoanthus incrustatus + hermit crab	abundant	Echinoid sp#1	v. abundant
Epizoanthus incrustatus + hermit crab	v. abundant	Prawn sp#2	abundant	Prawn sp#2	v. abundant
Prawn sp#4	v. abundant	Prawn sp#3	abundant	Prawn sp#3	v. abundant
Prawn sp#2	abundant			Stichopus sp#1	abundant
Haul 6					
Epizoanthus incrustatus + hermit crab	v. abundant				
Holothurian sp#4	v. abundant				
Anthozoa sp#1	abundant				
750m		**750m**		**750m**	
Haul 7		Haul 14		Haul 19	
Pasiphaea sp#2	few	Echinoid sp#3	v. abundant	Echinoid sp#3	v.v.abundant
Ophiuroidea spp	numerous			Holothurian sp#5	v. abundant
		Haul 25		Prawn sp#2	v. abundant
		Echinoid sp#3	numerous		
				Haul 22	
				Dichelopandalus bonnieri	v. abundant
				Holothurian sp#5	v. abundant
				Prawn sp#7	abundant
				Pseudomaussium septemradiatum	abundant
500m		**500m**		**500m**	
Haul 8		Haul 23		Haul 21	
Dichelopandalus bonnieri	few	Echinoid sp#4	abundant	Dichelopandalus bonnieri	v. abundant
				Holothurian sp#5	v. abundant
Haul 9		Hual 26		Pseudomaussium septemradiatum	v. abundant
Balanus hameri	few	Echinoid sp#4	v. abundant		
Echinoid sp#4	few	Holothurian sp#5	abundant		
Prawn sp#2	few				
Haul 10					
Echinoid sp#4	few				

Table 11. Number of samples for stable isotope analyses

Species	Tissue	Otolith
Alepocephalus bairdii	57	12
Antimora rostrata	10	10
Aphanopus carbo	60	38
Apristurus aphyodes	5	
Apristurus longiceps	5	
Argentina silus	20	
Bathypterois dubius	6	6
Brosme brosme	2	
Cataetyx laticeps	10	5
Centroscymnus coeleopis	6	
Centroscymnus crepidata	56	
Ceolorhynchus ceol-orhynchus	12	12
Chalinura mediterranea	16	12
Chimera monstrosa	30	
Coelorhynchus coelorhynchus	10	
Coelorhynchus labiatus	22	12
Coryphaenoides guntheri	20	11
Coryphaenoides rupestris	98	59
Cottonculus thompsonii	5	5
Deania calceus	20	
Epigonus telescopus	12	12

Halargyreus affinis	5	1
Helicolenus dactylopterus	11	8
Hoplostethus atlanticus	57	6
Hydrolagus mirabilis	25	
Lepidion eques	71	11
Macrocephalus sp		1
Micromesistius poutas-sou	10	7
Molva dypterygia	14	
Mora moro	13	13
Nezumia aequalis	47	12
Notacanthus bonaparte	9	
Phycis blennoides	9	11
Rhinochimaera atlantica	11	
Rouleina sp	19	12
Synaphobranchus kaupi	20	5
Trachyrhyncus murrayi	55	18
Xenodermichthyes copei	24	
Total	882	299

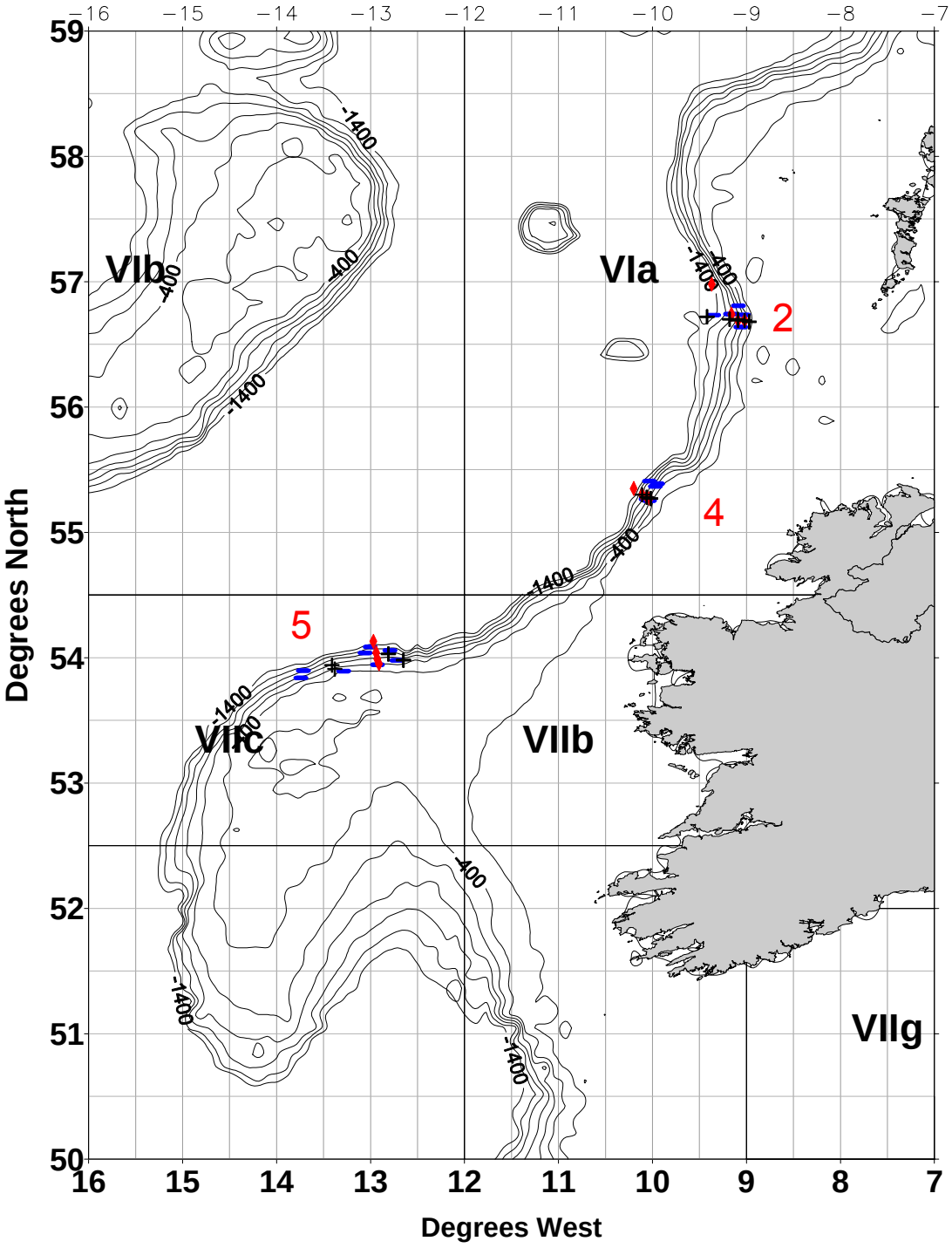


Figure 1. Survey area of deepwater program in 2006. Crosses refer to Grab samples, red diamonds are CTD positions, and blue lines are trawl tows.

Area five

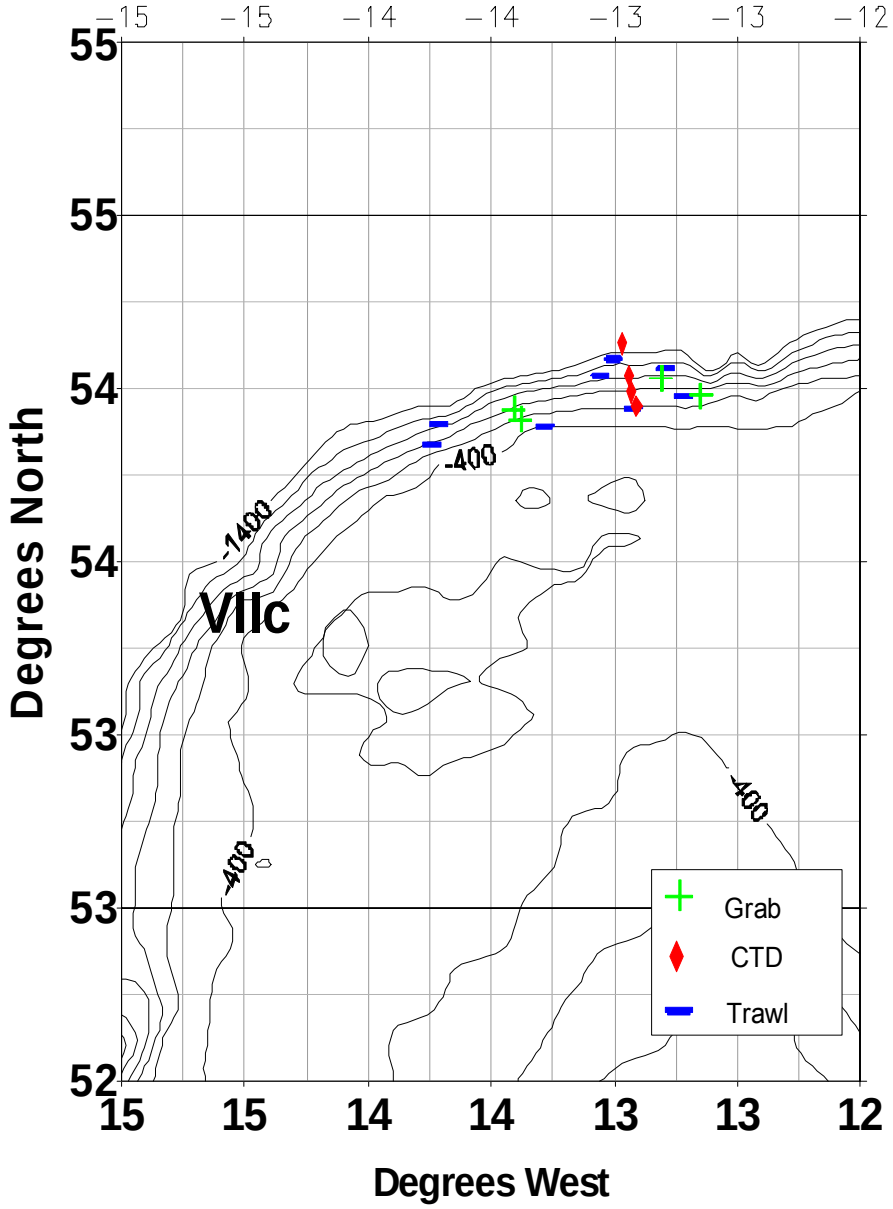


Fig 2. Survey sub 5 on the northern slope of the Porcupine bank. Blue lines refer to towing positions, red diamonds are CTD positions, and green crosses indicate grab hauls.

Area 2 and 4

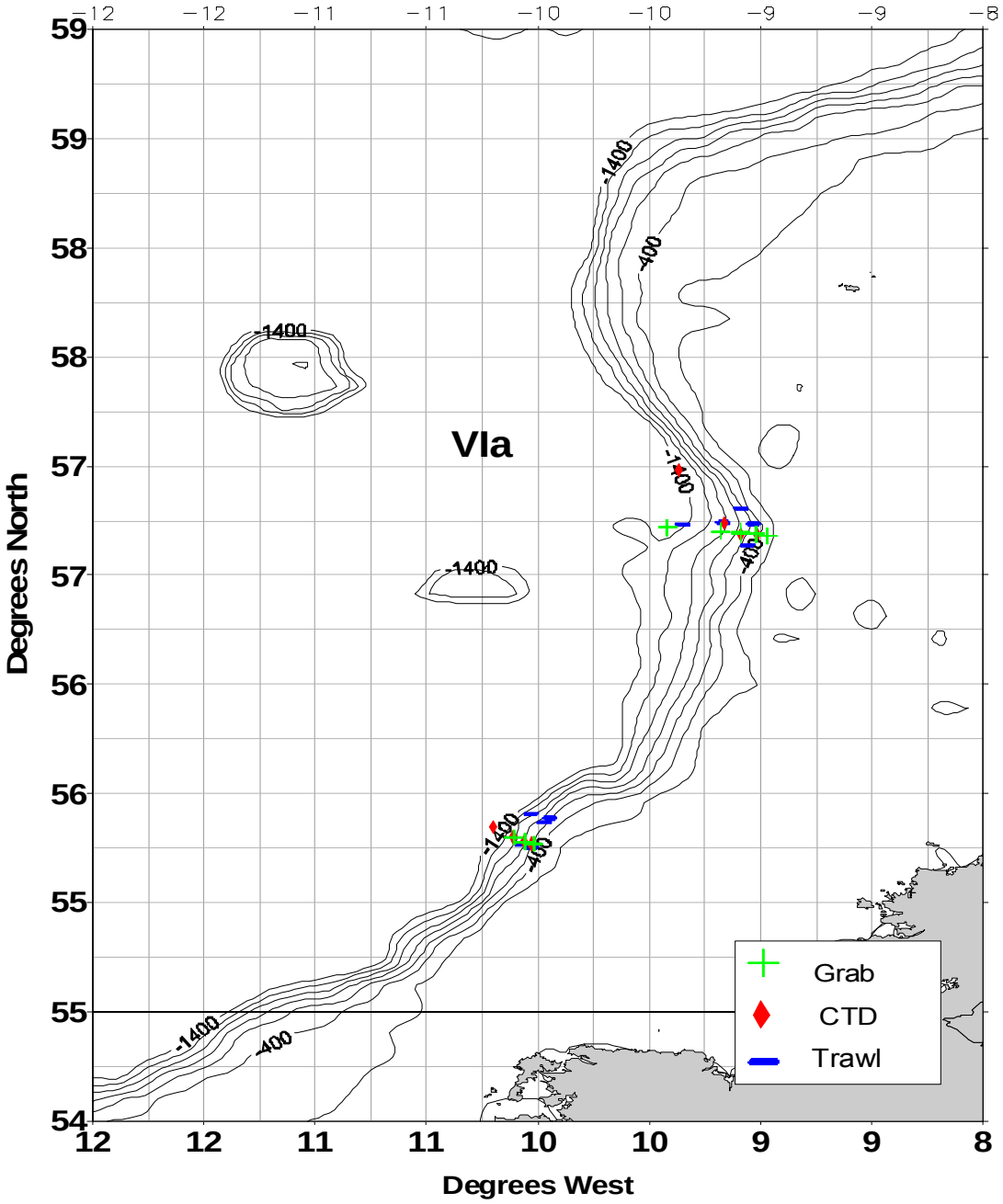


Fig 3. Survey sub areas 2 and 4 on the NW shelf slope. Blue lines refer to towing positions, red diamonds are CTD positions, and green crosses indicate grab hauls

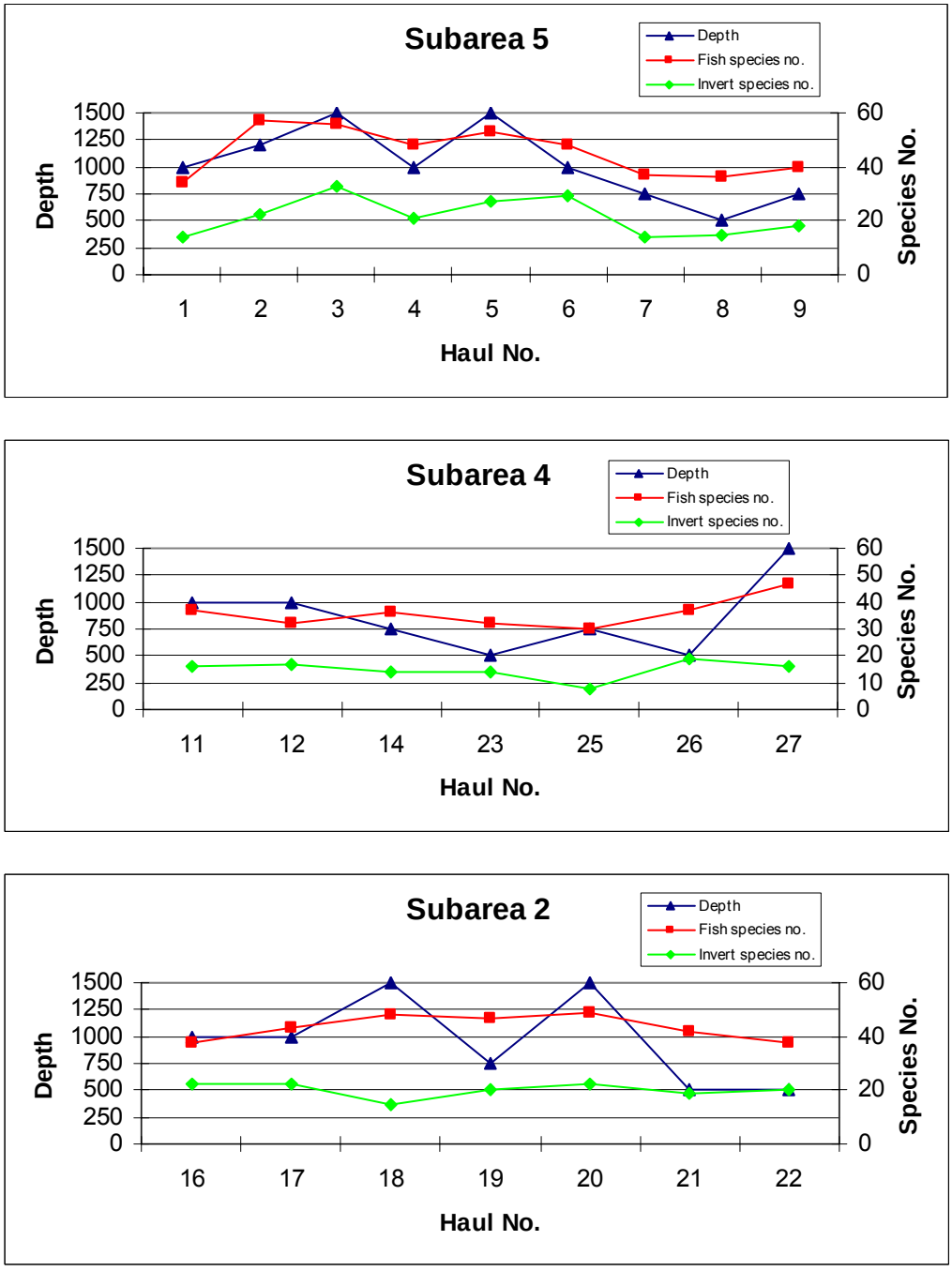


Figure 4. Fish and Invertebrate species numbers per depth for trawl sites

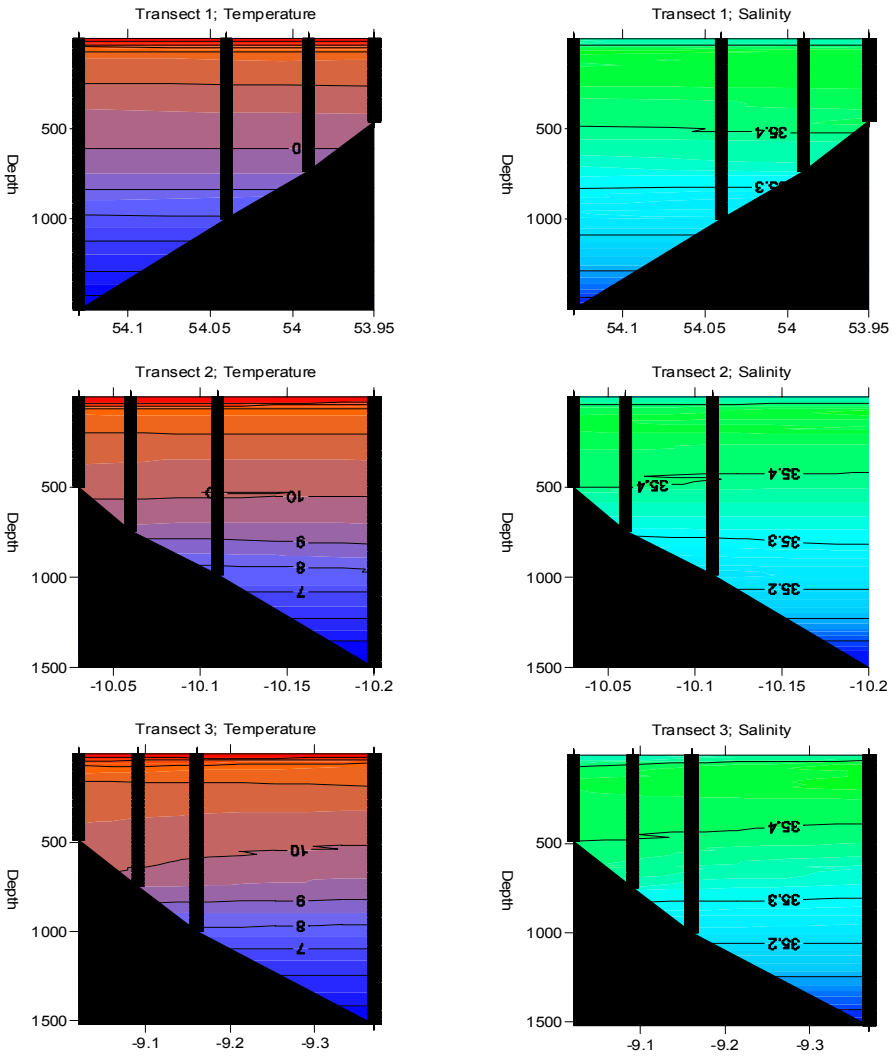
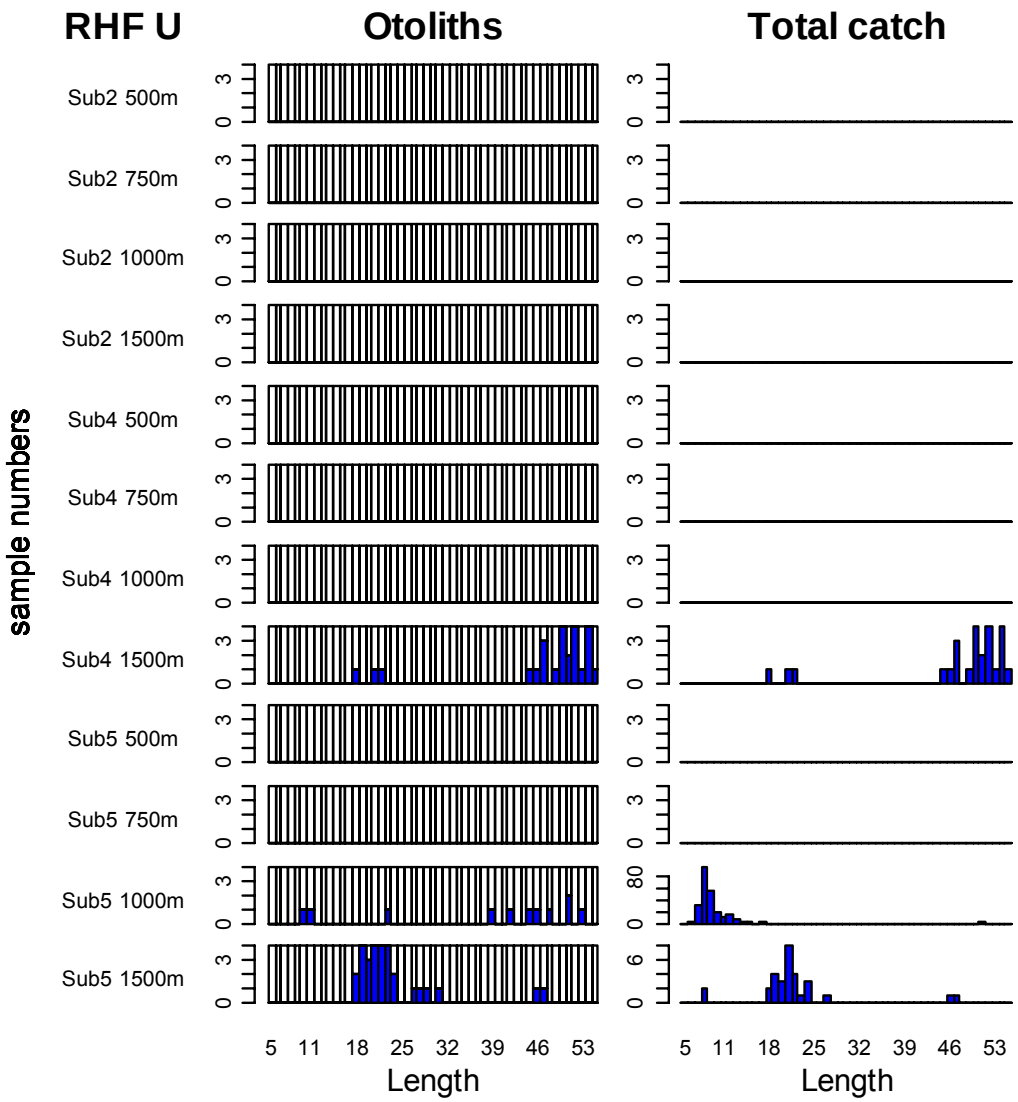
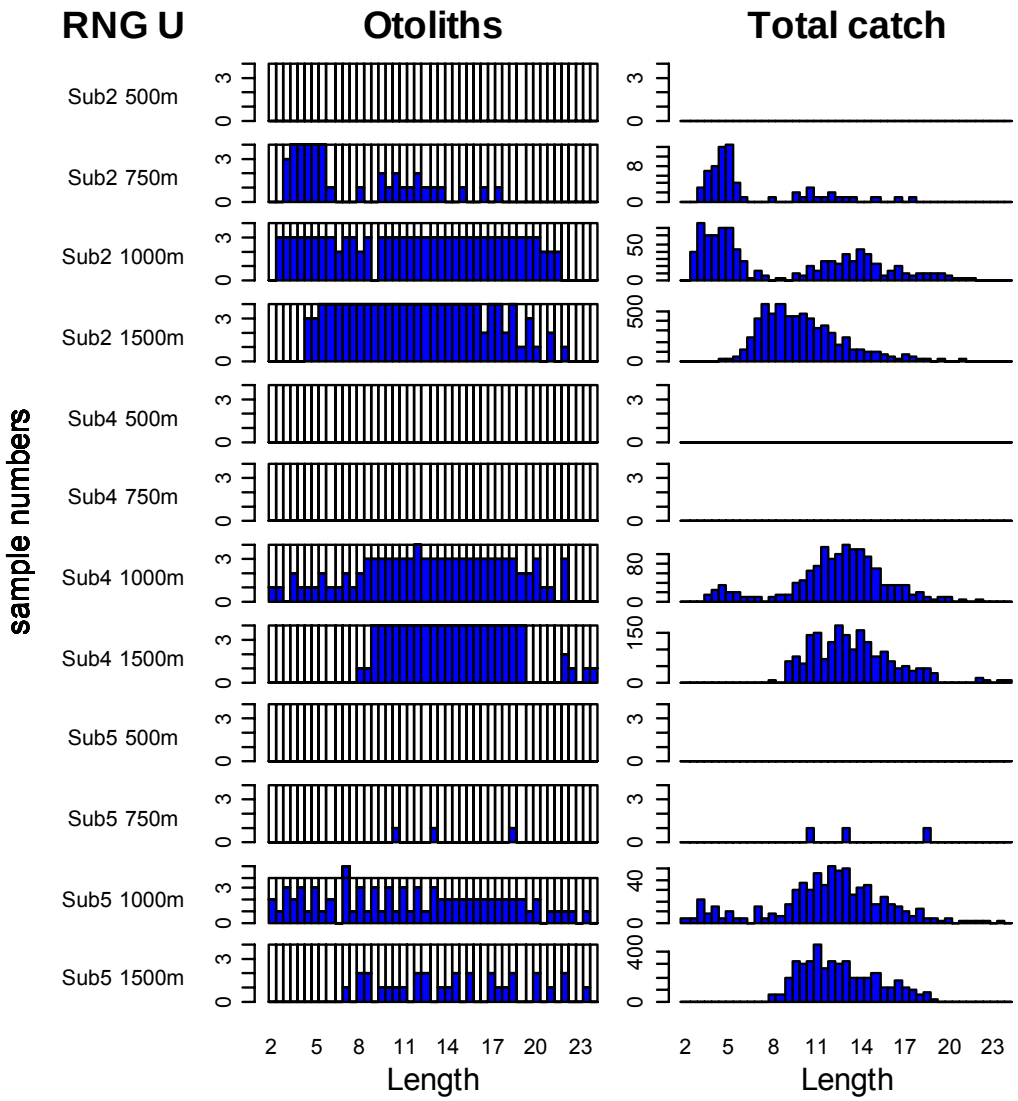


Figure 5. CTD plots of temperature and salinity of the three transects.

The following figures show the length distribution of the biological samples (left) and catch (right) for some of the target species by depth and area:




RNG U
Otoliths
Total catch
sample numbers
Sub2 500m
Sub2 750m
Sub2 1000m
Sub2 1500m
Sub4 500m
Sub4 750m
Sub4 1000m
Sub4 1500m
Sub5 500m
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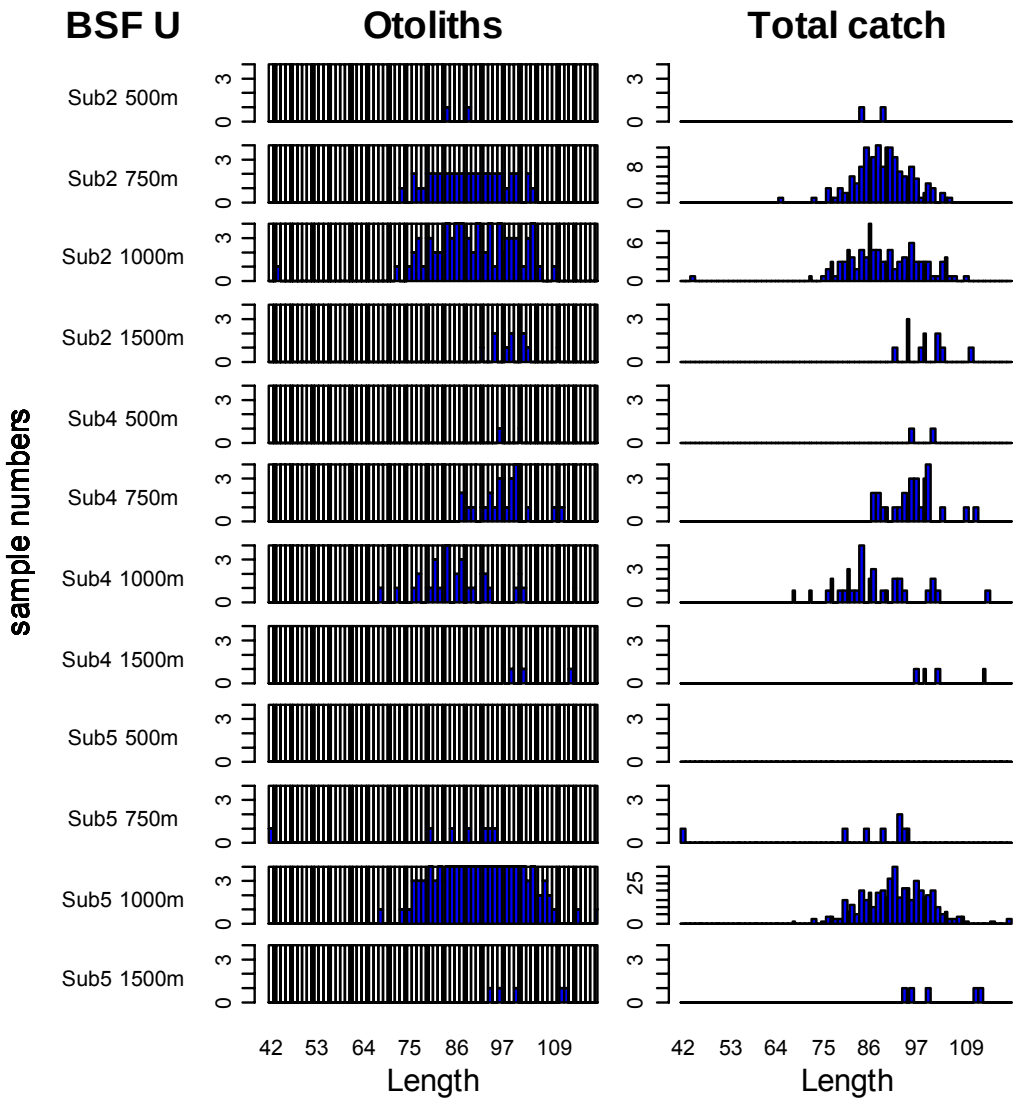
0 400
2 5 8 11 14 17 20 23
Length


BSF U
Otoliths
Total catch
sample numbers
Sub2 500m
Sub2 750m
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Sub2 1500m
Sub4 500m
Sub4 750m
Sub4 1000m
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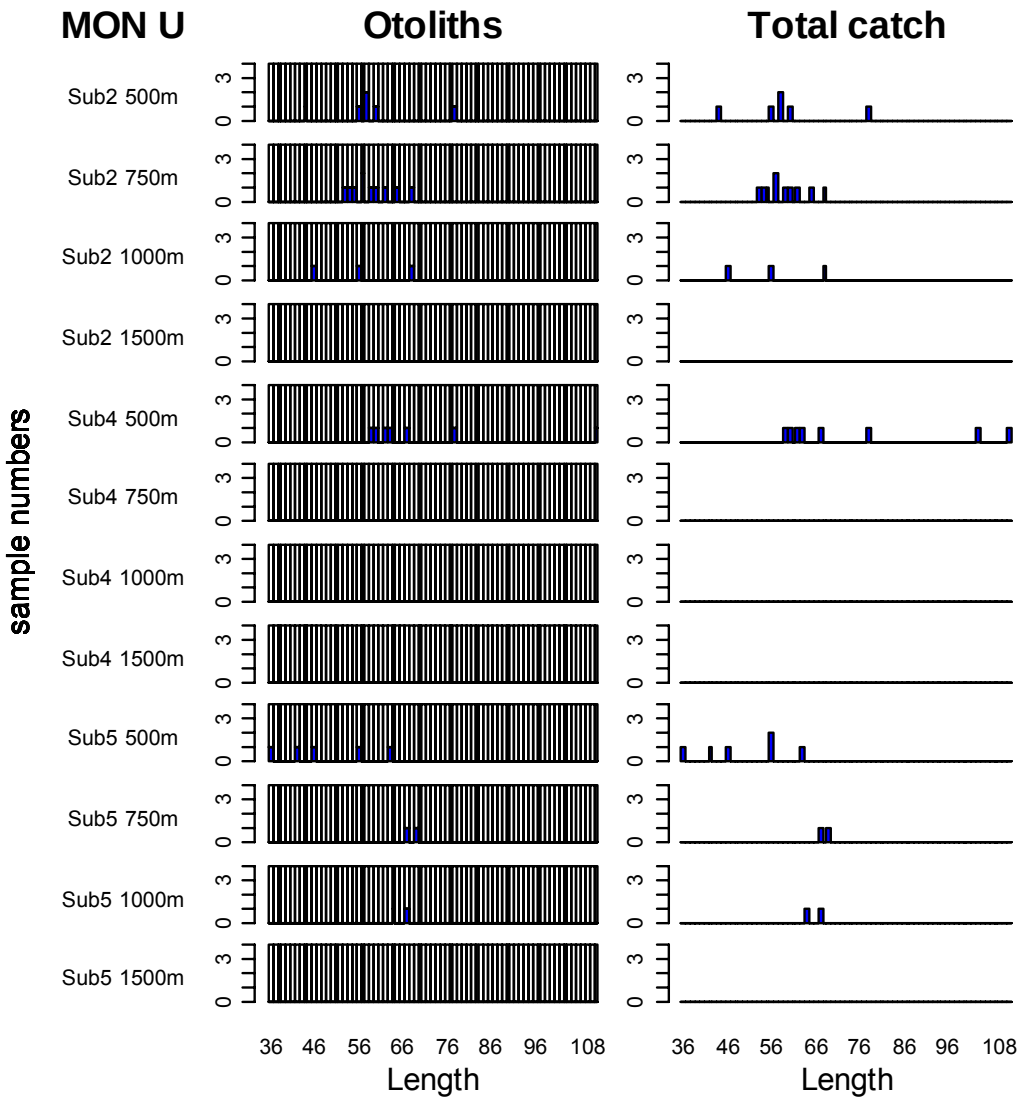
0 25
42 53 64 75 86 97 109
Length


MON U
Otoliths
Total catch
sample numbers
Sub2 500m
Sub2 750m
Sub2 1000m
Sub2 1500m
Sub4 500m
Sub4 750m
Sub4 1000m
Sub4 1500m
Sub5 500m
Sub5 750m
Sub5 1000m
Sub5 1500m
0 3
36 46 56 66 76 86 96 108
Length

Acknowledgements

Many thanks to Dave Stokes and Frankie Griffin for all the help they gave getting the survey on the road. Thanks as well to all the net builders, who gave freely of their time.

Thanks are expressed to Nils-Roar Hareide and Finlay Burns for their participation in the survey, and the wealth of experience they brought to fish identification. As teachers they were excellent.

Much appreciation is also expressed to the skipper and crew of the *Celtic Explorer.* They had plenty of chances to show all their various skills during the survey.

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Appendices

Survey Narrative

Date	Events
Friday, Sept 1st:	The final pre-cruise meeting was held at the Marine Institute in Oranmore. Participants were; Leonie Dransfeld, Nils-Roar Hareide, Brendan O' Hea, Graham Johnston, Hans Gerritsen, Mairead Sullivan, Stephen Comerford, Yvonne Leahy and Edward McCormack. Issues connected to security and sampling were discussed. The survey programme was gone through and discussed, and no important changes were made. It was decided that Hans would be responsible for storing the fish sampling data, Graham will be responsible for collecting and storing the acoustic data, Brendan will be responsible for CTD data collection, and Yvonne will be responsible for all benthic work. Yvonne will be present when hauls come in to ensure that no important invertebrates are discarded. It was also stressed that it is important to monitor the performance of the fishing gear, e.g. door spread and vertical opening. It was decided to trawl during daylight hours, and do CTD's and grab samples at night. It was also decided to take photos of all fish species caught during the survey, and also, if possible, all of the invertebrates. There is a need for flexibility in sampling strategy, and participants should be willing to assist each other in their various work programmes.
Saturday, Sept 2nd:	The two nets arrived and were found not to be built to specification, however work commenced on the construction of the first trawl
Sunday, Sept 3rd:	Construction of the second trawl was completed.
Monday, Sept 4th:	The trawls were loaded on board the *Celtic Explorer*. The bridles and sweeps arrived at 22.30, and were cut to the correct lengths. All scientists were aboard by 20.30. The safety briefing was given by the First Mate, and survival and medical certificates were checked.
Tuesday, Sept 5th:	Left Galway at 02.30, and steamed for position 53º 50N, 13º 00W. A briefing was held at 13.00, and Hans demonstrated the working of the wet lab. All necessary equipment was unpacked and stored where needed. Data on towing positions for Area 5 were given to the skipper. A decision was made on the location of towing rectangles, which were judged to be safe. The evening meeting took place at 19.00. Participants included the skipper, first mate, bosun, Nils, Hans, and Brendan. It was agreed to conduct a test tow upon arrival in Area 5. CTD casts would then be taken during Tuesday night, with grab samples being collected on Wednesday night. Trawling would commence at 06.00 on Wednesday morning. We defined shooting the doors as the start of the tow. We note the time and position of the doors hitting the ground. End of tow is when we start hauling the gear. Tows will be made along depth contours. The ship will alter course to follow the initial contour line, and won't just tow in a straight line. We arrived in Area 5 at 17.00.

	Haul No. 1. The trawl was shot at position 54º 03.48N 12º 47.65W at 17.35 in 1145m depth. The trawl touched bottom at 20.15, at position 54º 03.41N 12º 53.01W. It was hauled at 21.06 at position 54º 03.49N 12º 56.27W. The trawl got stuck after 45 minutes, and was hauled up. As it came aboard some gillnet twine was noticed on the sweeps. When the net arrived in it was found that one of the top bridles, the tickler chain, and four floats had broken. The net itself was undamaged. The fish in the haul were worked up. The most abundant benthic species of macroinvertebrates were *Stichopus sp* (Holothurian), "eared octopus", and green echinoids. Three hermit crabs with encrusting coral were found. One hermit crab was identified to species level, *Epizoanthus incrustatus* with *Parapagurus pilosimonies.* Representatives of all the abundant species were kept for isotope analysis. One 'sea pen' was collected for P. Tyler (SOC) and was fixed in alcohol. Examples of all invertebrates found were fixed in formalin for identification in MI. **CTD:** CTD's were conducted later in the night at four depths. Cast 1 23.35 1502m 54º 07.844N 12º 58.392W Cast 2 01.33 998m 54º 02.313N 12º 56.545W Cast 3 02.50 734m 53º 59.521N 12º 55.621W Cast 4 03.50 460m 53º 56.834N 12º 54.699W All casts were successful.
Wednesday, Sept 6th:	**Haul No. 2.** The trawl was shot at position 54º 05.15N 13º 00.19W at 06.26 in 1280m depth. The trawl touched bottom at 07.10, at position 54º 05.29N 12º 55.72W. It was hauled at 09.10 at position 54º 04.92N 12º 45.35W. Once again the tickler chain had broken. The ER60 was started at roughly 02.30 after calibration with the CTD data. **Haul No. 3.** The trawl was shot at position 54º 07.95N 12º 48.96W at 10.58 in 1500m depth. The trawl touched bottom at 11.35, at position 54º 07.40N 12º 53.23W. It was hauled at 13.42 at position 54º 07.36N 13º 02.70W. The tickler chain had broken. The trawl caught a bundle of discarded monkfish gillnets, (picture taken). We will record whether or not we catch nets or other fishing gears in all hauls. This may be useful information for the Deepnet project. The haul was approximately 2 tonnes, and consisted mainly of Roundnose grenadiers, with a large variety of other species. **Haul No. 4.** The trawl was shot at position 54º 02.29N 13º 03.49W at 15.48 in 1000m depth. The trawl touched bottom at 16.22, at position 54º 02.22N 12º 59.18W. It was hauled at 17.52 at position 54º 01.87N 12º 50.44W. The tickler chain was left off during this haul due to our inability to record when the chain breaks. The net was hauled after 1.5 hours effective fishing time, in order to reduce catch volume. The haul produced between 500kg and 700kg of fish. We also brought up some gillnets. Due to the small mesh being used we are catching species that are not seen in commercial catches. It was decided to freeze samples of all fish where we are unsure of identification. Flesh samples were collected for genetic analysis from Black Scabbard and *Deania calcea*. **Grabs:** We attempted a number of Grab samples at 1500m and 1000m, with little success. The Hammon grab was used first at 1000m. It had a small amount of sediment. This was sieved on 0.63µm mesh with evidence of some fauna. Next we tried the Shipek grab, which produced even less sediment, and no evidence of fauna. Moved out to 1500m, and deployed the Hammon grab

	twice, with no success. The grab didn't trigger on either occasion. It was decided to attempt shallower grab samples tomorrow night. The invertebrate fauna from the hauls were mainly echinoderms, (Holothurians, Asteroids and Echinoderms), crustacea, (Prawns, Squat lobsters and Spider crabs), and soft coral with hermit crabs. Surprises were two species, four individuals, of scaleworm, Polynoidae. The evening meeting with the skipper, engineer and bosun was held at 1900.
Thursday, Sept 7th:	We moved to the western part of Area 5 during the night. The first haul was made at 1500m, and it was decided to work our way up the slope to 500m. It was also decided to leave the tickler chain off permanently. Since it is breaking each tow, and we don't know at what stage, it is generating added uncertainty in the data. Did an hour of identification training, using only scientific names rather than common names. **Haul No. 5.** The trawl was shot at position 53º 56.38N 13º 57.77W at 06.44 in 1500m depth. The trawl touched bottom at 07.29, at position 53º 56.38N 13º 52.12W. It was hauled at 09.08 at position 53º 58.80N 13º 45.10W. The catch was approximately 1.5 tonnes. The most abundant species was *Coryphaenoides rupestris.* There were very few *Centroscymnus colelolepsis* in depths of 1000m to 1500m. In this tow we caught numbers of *Hoplostethus atlanticus* ranging from 10cm to 25cm. In earlier tows this size class was absent. **Haul No. 6.** The trawl was shot at position 53º 53.80N 13º 42.85W at 10.50 in 1000m depth. The trawl touched bottom at 11.25, at position 53º 52.79N 13º 47.05W. It was hauled at 12.57 at position 53º 50.74N 13º 54.14W. After finishing haul 6 we steamed south to the 750m contour line. We followed this line for a period of time to check out the ground. It was decided that the 1995 tow was suitable for about 3nm **Haul No. 7.** The trawl was shot at position 53º 50.31N 13º 44.50W at 15.09 in 750m depth. The trawl touched bottom at 15.30, at position 53º 49.85N 13º 46.77W. It was hauled at 15.59 at position 53º 49.37N 13º 48.57W. We came fast after 30 minutes effective towing, so we hauled the net, again without sustaining any damage. The haul contained approximately 500kg of fish. We steamed to the 500m contour, following it eastward, again looking for a suitable towing area. It was decided that it would be safer to tow along the 450m contour. **Haul No. 8.** The trawl was shot at position 53º 53.59N 13º 17.12W at 19.40 in 430m depth. The trawl touched bottom at 1950, at position 53º 53.55N 13º 17.84W. It was hauled at 21.42 at position 53º 52.00N 13º 28.56W. The trawl brought up some sheeting from old nets. Flesh samples were again collected for genetic analysis from *Coryphaenoides rupestris*, *Aphanopus carbo*, and *Centrophorus squamosus*. The evening meeting with the skipper was cancelled due to shooting the net for haul no. 8. **Grabs:** After the last haul of the day we steamed to the 1000m contour line to deploy the grab. Two attempts were made with the Hammon grab, which failed to trigger on either occasion. After moving to the 750m contour the Hammon grab again failed to trigger, so it was decided to continue with the Shipek grab. This produced a small sample, but there were some traces of fauna, including polychaete tubes and a strange brittle star (ophiuroid). At the 500m contour the Hammon grab was tried again. It worked this time producing a good sediment sample, containing tiny squat lobsters and other invertebrate fauna. Among both samples collected there was evidence of "hard substrate" among the fine sand. This may have contributed to the equipment problems. While doing the grabs we were also searching for suitable areas for towing along the 750m contour.
Friday,	**Haul No. 9.** The trawl was shot at position 53º 58.74N 12º 43.23W at 06.33 in 750m depth. The

Sept 8th:	trawl touched bottom at 07.01, at position 53º 59.31N 12º 46.61W. It was hauled at 08.50 at position 53º 59.32N 12º 56.37W. The main catch consisted of *Daenia calceus* and *Chimaera monstrosa*. We also brought up some longlines, and approximately 30m of wire. After concluding haul 9 we searched for suitable ground at 500m. The 500m contour is exactly on the shelf break, and has a coral reef running right along it, almost like a barrier. We eventually found an area where we could trawl for approximately one hour. **Haul No. 10.** The trawl was shot at position 53º 56.65N 12º 55.55W at 11.45 in 450m depth. The trawl touched bottom at 12.05, at position 53º 56.82N 12º 53.45W. It was hauled at 12.13 at position 53º 56.80N 12º 52.42W. The net got stuck after roughly five minutes of the tow. It was hauled up with one box of fish in it. However it was torn in two sections in the belly. While these were being repaired it was decided to steam to Area 4 for the next section of the survey. Flesh samples were collected from *Centrophorus squamosus*, and *Daenia calcea*. **Grabs:** Two final grab samples were collected slightly to the east of Area 5, in order to see if there were better sediments in the canyons. We steamed for area 4 at 16.55 in the afternoon. After finishing the regular sampling on haul 10, time was spent training the scientists on the maturity stages of *Chimaera monstrosa*, *Hydrolagus mirabilis*, and *Daenia calceus*. The evening meeting with the skipper took place at 1900. A preliminary work programme for area 4 was presented and commented. It was suggested that we should concentrate on the deeper sites in area 4, and then move on to area 2, before coming back to finish off the shallower sites in area 4. It was felt that the risk of gear damage was greater at the shallower sites. At 2000 a meeting was held among the scientists. Information from the different work being carried out was circulated. Sampling strategies were discussed, and it was decided to raise the target for otoliths of Black scabbard to 6 per 1cm length group per area. It was also suggested that a little more time should be used for biological investigations, as we had done earlier in the day. It was also suggested that information on current location, and depths being fished should be poster on boards so that scientists would have a better idea of where they were. The trawl repairs were finally finished at 2200. The bosun noted that the new mesh put on the underside of the trawl had a slightly smaller mesh size.
Saturday, Sept 9th:	We arrived in area 4 after midnight. We steamed along the 1000m contour line, searching for good trawling ground. The best ground was found to be in the northern half of the survey area. This was the part of area 4 we had positions on valid tows from the 1990s surveys. We decided to start towing at 1000m. **Haul No. 11.** The trawl was shot at position 55º 24.51N 10º 01.89W at 06.37 in 1000m depth. The trawl touched bottom at 07.05, at position 55º 22.31N 10º 04.21W. It was hauled at 09.05 at position 55º 17.18N 10º 07.38W. The ground was a bit harder than similar depths in area 5 but the tow proceeded without incident. The total catch after the two hour haul was approximately 750kg. The main catch was *Coryphaenoides rupestris*. The total catch of Smoothheads was smaller compared to area 5. **Haul No. 12.** The trawl was shot at position 55º 14.05N 10º 09.13W at 12.15 in 1055m depth. The trawl touched bottom at 12.54, at position 55º 12.03N 10º 10.00W. It was hauled at 14.12 at position 55º 08.66N 10º 10.19W. This was one of the comparison tows with the RV *Scotia*, and again it passed off without a problem.

	Haul No. 13. This tow was another of the comparison tows. We steamed along the 1500m contour line, to check the ground before shooting. The ground looked a bit hard and difficult. The trawl was shot at position 55º 06.04N 10º 16.48W at 15.53 in 1580m depth. The trawl touched bottom at 16.39, at position 55º 05.74N 10º 15.95W. It was hauled at 16.48 at position 55º 10.07N 10º 16.15W. The net came fast after ten minutes towing. It took 30 minutes to free it. The net came to the surface with only a few small tears, which were easily repaired. It contained a large lump of clay, (see photo). This provided a large sample for the benthic team. During the tow the Trawleye seemed to stop transmitting as soon as it touched bottom, but started transmitting again as the net started to rise. At the evening meeting with the skipper it was decided to carry out CTD and grabs overnight. The CTD's would be carried out at four depths, but grab samples would only be collected at three, missing out the 1500m level. After this work the ship would steam looking for good trawling grounds. The scientists then had a meeting to discuss current work, and make plans for the coming days. **CTD:** Cast 5 20.27 1502m 55º 20.528 N 10º 12.257W Cast 6 22.15 988m 55º 17.945 N 10º 06.475W Cast 7 00.32 746m 55º 16.849 N 10º 03.580W Cast 8 02.25 502m 55º 16.069 N 10º 01.502W **Grabs:** The three grab samples were collected at the last three CTD stations. We started with the Hammon grab at 1000m. Once again it didn't work properly. We sent the Shipek grab down, which worked well. It produced a sample of sand with some small pebbles. There was also one echinoid present. Due to time constraints it was decided to only use the Shipek at 750m, and use the Hammon at 500m. Two Shipek samples were collected at 750m, and got good faunal returns on both occasions. We tried the Hammon at 500m, without success. It never triggered, but mud on both the box and frame showed that it had hit the bottom. We took two Shipek hauls as well and on both occasions got a full box of soft mud. It is felt that the Hammon grab is out of line, and that it is an equipment fault rather than its unsuitability for the ground or the depth. We worked on the clay stone in the afternoon. There were lots of biological samples in the first 2.5cm to 4cm. There was a clear line of sediment differentiation at 9cm, changing in colour from tan brown to dark grey. This is the chemical Fe^{3+}/Fe^{4+} boundary. The surface was pitted with holes. These contained ophiuroids, (possibly up to three species), Sabellid polychaetes, (plus other unidentified polychaetes), amphipod juvenile stages, and anemones. Another obvious feature were areas of blue, which turned out to be a sponge species. Green sponge areas were also present, but were not as obvious.
Sunday, Sept 10th:	After the CTD and grab samples were collected the ship searched for suitable trawl grounds along the 750m and 500m contours. Suitable areas were found, especially along the 500m line. **Haul No. 14.** The trawl was shot at position 55º 15.88N 10º 04.03W at 06.25 in 750m depth. The trawl touched bottom at 06.50, at position 55º 17.56N 10º 03.24W. It was hauled at 08.50 at position 55º 23.09N 09º 59.35W. The net was towed effectively for two hours. The total catch was ap-

	proximately 750kg, with a mixture of upper slope and deep water species. We decided to carry out extra biological sampling on *Chimaera monstrosa* and *Phycis blennoides*. **Haul No. 15.** The trawl was shot at position 55º 23.31N 09º 56.82W at 10.02 in 540m depth. The trawl touched bottom at 10.20, at position 55º 22.06N 09º 58.17W. It was hauled at 12.20 at position 55º 16.40N 10º 01.18W. The bottom came up during shooting and the net landed at 510m. We hauled after two hours effective trawling. The belly was badly torn, and the catch was only six boxes. The bosun estimated it would take five to eight hours to repair the net. It was decided to steam to area 2 while this was being done. We arrived in area 2 at 2100 and started doing CTD's and grab samples. It was decided to collect samples at 1500m, 1000m, 750m, and 500m. Afterwards the ship would attempt to locate good trawling grounds. **CTD:** Cast 9 21.55 1508m 56º 43.416 N 09º 25.031W After the first set of CTD casts and grab samples it was realised that there wouldn't be enough time to complete the full set during the night. It was decided to stop the CTD's and concentrate on the grabs. **Grabs:** Two Shipek samples were collected at 1500m, 1000m, and 750m. The samples from the first two sites were very soft mud, and contained lots of polychaete tubes. The samples from 750m were sandier, and also contained polychaete tubes, and possibly a terebellid tube. We ran out of time to sample the 500m site.
Monday, Sept 11th:	It was planned to start trawling at 06.00 as usual, but we needed more time to scout out areas on the 1000m contour line. The planned trawling route contained some "hard" patches. **Haul No. 16.** The trawl was shot at position 56º 39.82N 09º 12.11W at 08.05 in 985m depth. The trawl touched bottom at 08.50, at position 56º 41.59N 09º 11.00W. It was hauled at 10.35 at position 56º 47.29N 09º 11.50W. This tow should have been one of the comparison tows with the *Scotia*, but due to the presence of some hard ground we moved the tow slightly to the south. The catch was approximately 500kg after nearly two hours towing. We also collected a few metres of hake longline. **Haul No. 17.** The trawl was shot at position 56º 44.53N 09º 10.13W at 11.55 in 1048m depth. The trawl touched bottom at 12.25, at position 56º 42.07N 09º 10.58W. It was hauled at 14.25 at position 56º 36.15N 09º 14.55W. **Haul No. 18.** The trawl was shot at position 56º 44.03N 09º 21.01W at 16.15 in 1425m depth. The trawl touched bottom at 17.00, at position 56º 47.33N 09º 21.01W. It was hauled at 19.05 at position 56º 52.82N 09º 20.60W. CTD casts were carried out at the four depths selected last night. Two sets of grab samples were also collected, at 500m and 200m. **CTD:** Cast 10 20.36 1526m 56º 53.568 N 09º 22.432W Cast 11 23.00 1001m 56º 44.286 N 09º 09.763W

	Cast 12 00.30 750m 56º 41.426 N 09º 05.252W Cast 13 01.25 491m 56º 41.173 N 09º 01.428W **Grabs:** Two grabs were collected with the Shipek at 500m. The grabs were ½ to ¾ full with sandy sediment. The fauna comprised Polychaete tubes and an Ophiuroid. The slope was too steep at 200m, so we moved into 170m. On the first grab a large pebble was stuck in the jaws of the bucket. The sediment collected was coarse sand and pebbles, with some Bryazoa on the pebbles. Although the second grab closed correctly, it collected very little sediment, with no visible fauna.
Tuesday, Sept 12th:	**Haul No. 19.** The trawl was shot at position 56º 45.48N 09º 05.19W at 06.35 in 750m depth. The trawl touched bottom at 06.50, at position 56º 46.53N 09º 05.66W. It was hauled at 08.30 at position 56º 50.43N 09º 08.11W. The depth started dropping away at the end of the tow. The net was hauled in early due to signs of hard ground at the end. The catch was approximately 1 tonne. It consisted mainly of *Phycis blennoides*, *C squamosus*, and bluemouth. There were also large numbers of *Aphanopus carbo*, *Lophius piscatorius*, with a couple of *Molva molva*, and *M. dipterygia*. We carried out some extra biological sampling on *Phycis blennoides* and *Epigonus telescopus*. We then steamed t the 1500m contour. **Haul No. 20.** The trawl was shot at position 56º 53.91N 09º 19.59W at 09.55 in 1475m depth. The trawl touched bottom at 10.35, at position 56º 51.89N 09º 20.60W. It was hauled at 12.35 at position 56º 45.60N 09º 21.24W. This tow was a repeat haul no.18. There were two reasons for this; 1) we know the tow is safe and is good for confidence, and 2) it may be better statistically to do comparative tows twice. The trawl touched bottom at 17.00, at position . It was hauled at 19.05 at position 56º 52.82N 09º 20.60W. We collected approximately two tons of fish after two hours effective trawling. We had the same species composition as in haul 18. We carried out some extra biological sampling on two of the small Grenadiers. Sex and maturity data was also collected on *Hydrolagus affinis*. We then steamed to the 500m contour line, following this southward, until we found suitable ground for trawling. **Haul No.21.** The trawl was shot at position 56º 38.28N 09º 03.60W at 15.40 in 490m depth. The trawl touched bottom at 16.00, at position 56º 39.67N 09º 01.89W. It was hauled at 18.00 at position 56º 45.19N 09º 02.22W. We towed northwards at 500m. The catch was mainly a mix of Forkbeards, Hake and Sharks. **Haul No.22.** The trawl was shot at position 56º 44.14N 09º 01.96W at 19.20 in 490m depth. The trawl touched bottom at 19.40, at position 56º 44.14N 09º 01.96W. It was hauled at 21.00 at position 56º 39.87N 09º 01.78W. Due to a lack of time to search for more clean ground this tow was the same as No. 21. We started steaming for area 4 at 22.00. We started searching for good ground along the 500m contour.
Wednesd. Sept 13th:	We arrived in area 4 at 08.00. We followed the 500m contour southwards to the site of the comparison tow with the RV *Scotia*. **Haul No. 23.** The trawl was shot at position 55º 22.01N 09º 58.15W at 10.10 in 550m depth. The trawl touched bottom at 10.30, at position 55º 20.63N 09º 58.73W, at a depth of 525m. It was hauled at 12.00 at position 55º 16.25N 10º 01.15W. This is the same ground as haul no. 15, where

	we tore the net. We avoided the hard ground in the northern part of the tow, and therefore had no problems. We caught approximately 1 tonne of fish. This comprised mainly *Chimaera monstrosa*, and *Argentina silus*, with some prime fish such as *Lophius piscatorius*, *Merluccius merluccius*, and *Molva molva*. **Haul No. 24.** The trawl was shot at position 55º 13.02N 10º 17.74W at 14.10 in 1470m depth. The trawl touched bottom at 14.45, at position. It was hauled at 15.10 at position 55º 09.79N 10º 16.86W. We shot the trawl at 1500m. The weather was blowing force 7, and not ideal. We had to haul after 25 minutes on the bottom due to some hard ground being spotted on the echosounder. We caught approximately 250kg of fish, which were sampled for biology. The small liner inside the cod-end was not in the right position, so we were only catching the larger fish. It was not a valid haul. We also trawled up approximately 100m of hake longline. We used the rest of the day and night searching for suitable fishing sites.
Thursday, Sept 14th:	**Haul No. 25.** The trawl was shot at position 55º 16.31N 10º 03.91W at 06.20 in 744m depth. The trawl touched bottom at 06.40, at position 55º 17.45N 10º 03.25W. It was hauled at 08.40 at position 55º 22.97N 09º 59.30W. The search during the night showed bad ground along most of the 750m contour. It was decided therefore to trawl the same track as haul no. 14. **Haul No. 26.** The trawl was shot at position 55º 15.18N 10º 01.93W at 10.10 in 495m depth. The trawl touched bottom at 10.30, at position 55º 13.73N 10º 02.86W. It was hauled at 12.30 at position 55º 08.23N 10º 04.74W. We found some good ground south of haul no.15. The haul was made successfully, with *Merluccius merluccius* being the main catch. We also brought aboard approximately 150m of hake longline. **Grabs:** To fill in the gaps in our sampling for area 4 it was decided to collect some samples from 750m. We used the Shipek, and got a good return on the first drop. It contained a small amount of sand, with no visible fauna. The second grab contained even less sand, again with no fauna visible. There is a strong current at 750m, and it is possible that the grab is hitting the bottom at an angle, and therefore is only skimming the surface. Heavier equipment, such as a box core, is needed for this depth. After the grabs we steamed southwest to the 1500m contour, in an area that showed good ground. **Haul No. 27.** The trawl was shot at position 54º 59.38N 10º 22.37W at 15.50 in 1350m depth. The trawl touched bottom at 16.40, at position 54º 58.11N 10º 26.72W, at a depth of 1465.. It was hauled at 18.30 at position 54º 56.01N 10º 33.16W. During the first half hour of the tow the ground was very bumpy. However it was quite good after this and we trawled successfully for two hours. The total catch was approximately 2.5 tonnes, including four boxes of *Hoplostethus atlanticus*. This concluded the survey and the ship steamed for Galway at 19.30.